Partly Cloudy Pixel Retrievals for 1-km MODIS Observations

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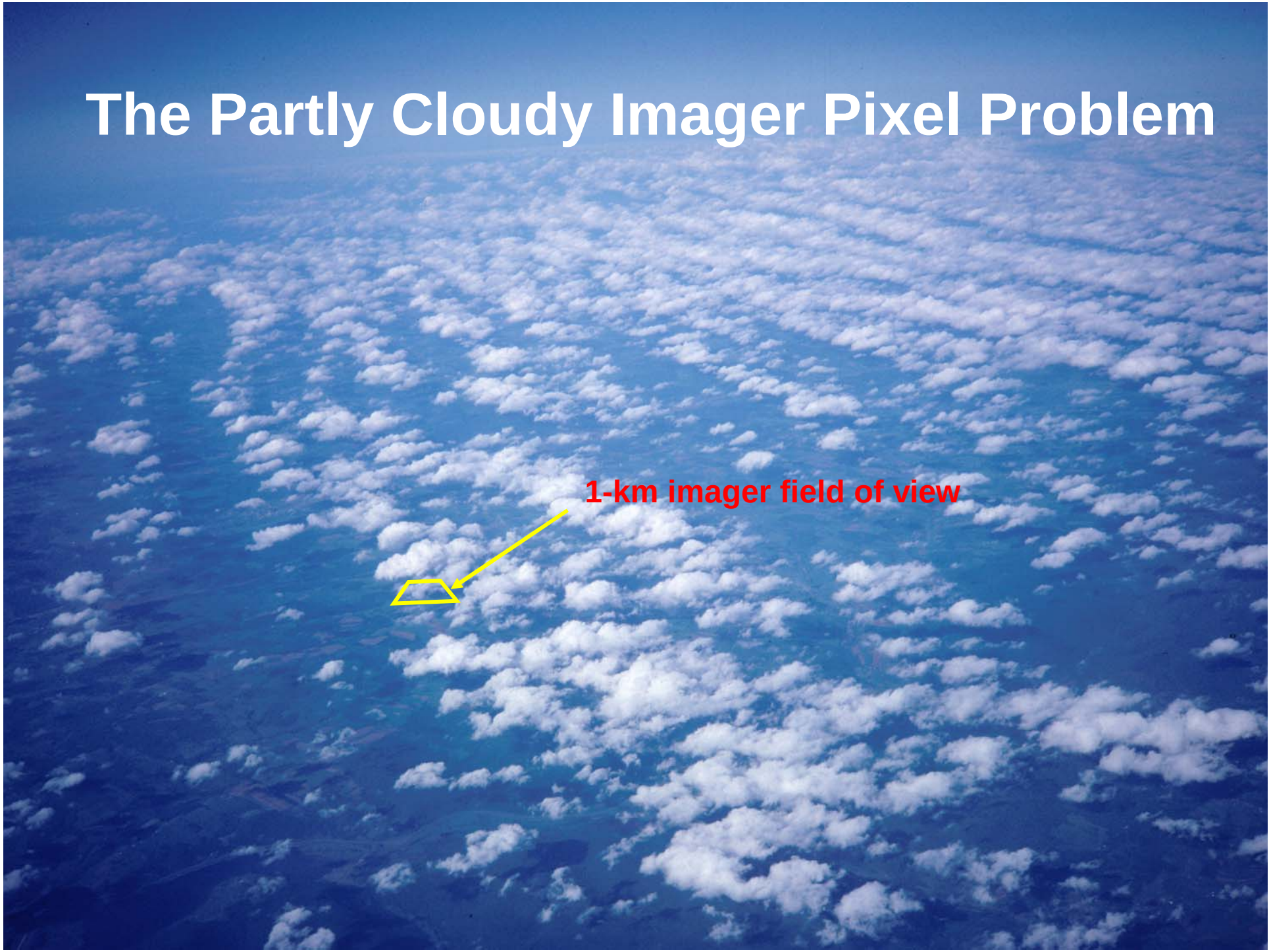
Goals:

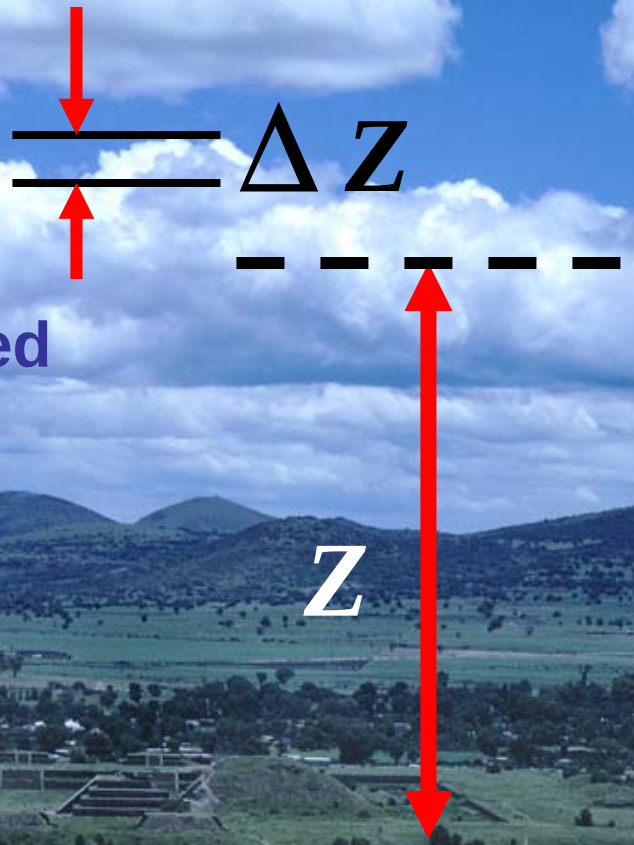
1) Implement partly cloudy pixel retrievals for the 1-km MODIS observations and assess biases in the MOD06 retrievals.

2) Assess feasibility of using shipboard measurements of radiative fluxes to validate CERES estimates of surface fluxes.

The Partly Cloudy Imager Pixel Problem



Assumption:



- Layer is reasonably well-defined

$$\Delta z << z$$

Condition:

- No overlying layers

Retrieval Method

Retrieval scheme follows Arking and Childs (1985) and is described in Coakley et al. (2005).

- **For single-layered cloud systems, identify overcast pixels and determine altitude of cloud layer.**
- **For each pixel, radiances are given by**

$$I = (1 - A_C) I_S + A_C I_C(z_C)$$

A_C **= Fractional cloud cover within a pixel**

I_S **= Average cloud-free radiance within a pixel**

$I_C(z_C)$ **= Average overcast radiance within a pixel**

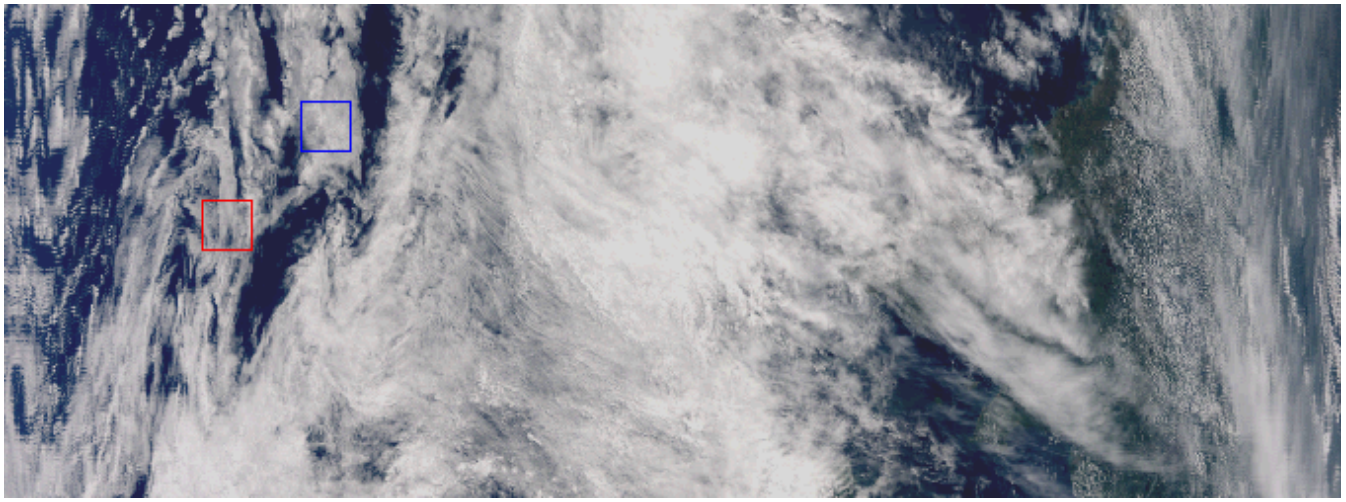
z_C **= Average cloud altitude obtained from nearby overcast pixels.**

- **For each pixel, adjust A_C, τ, R_e so that calculated radiances at 0.64, 1.6, 2.1, 3.7, and 11 μm match those observed.**

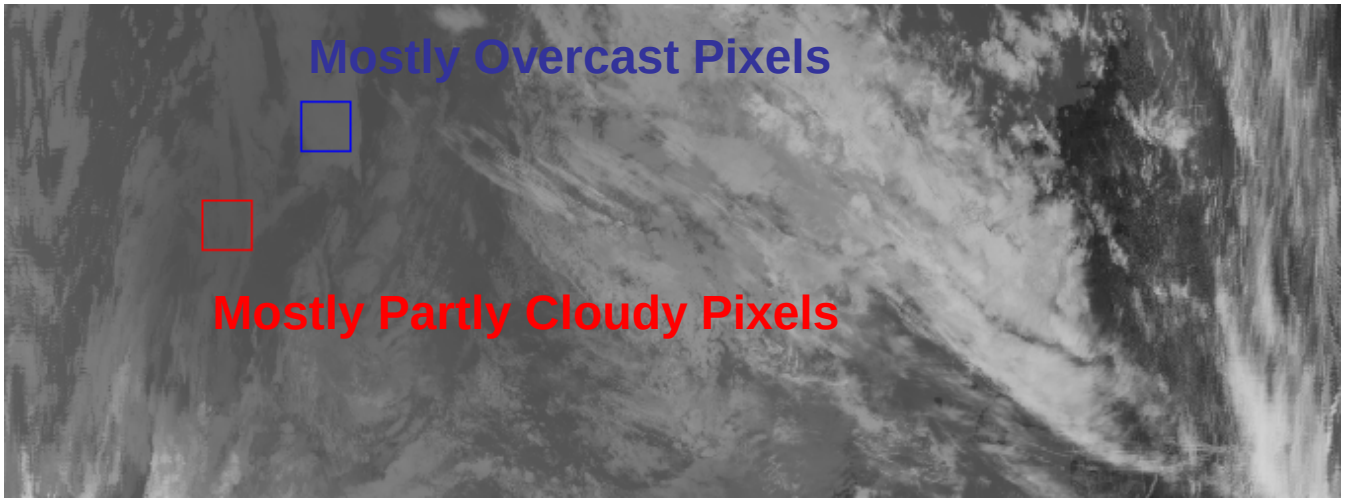
1-km MODIS Imagery

Terra **21 June 2002 1135 Z**

True Color

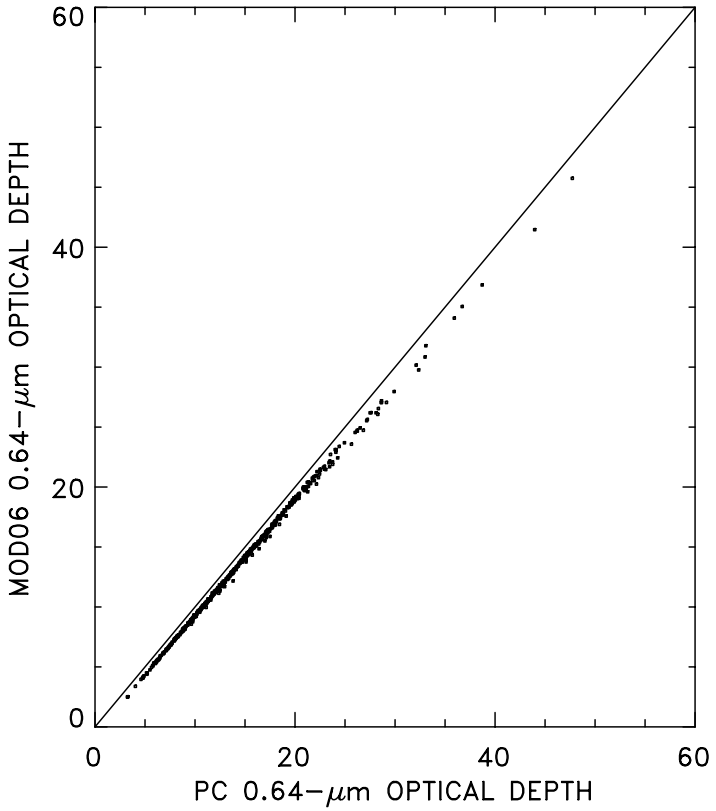


11-μm

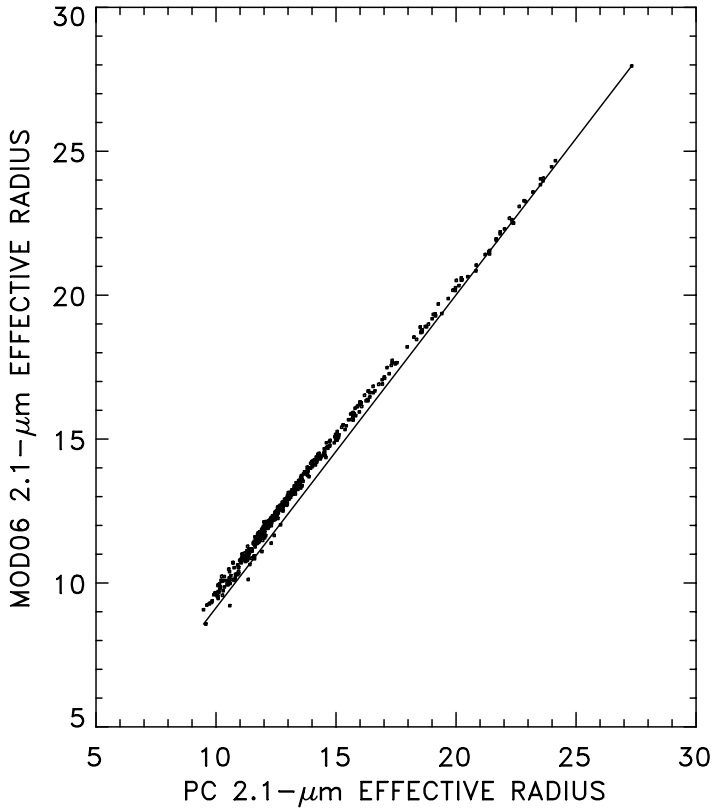


Optical Depth and Droplet Effective Radius for Overcast Pixels

0.64-μm Optical Depth



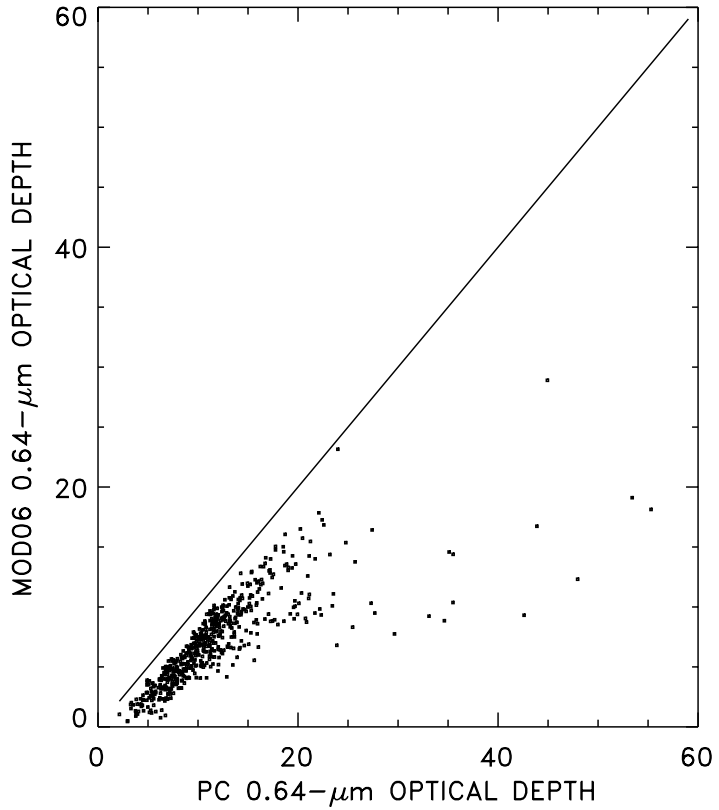
Droplet Radius at 2.1 μm



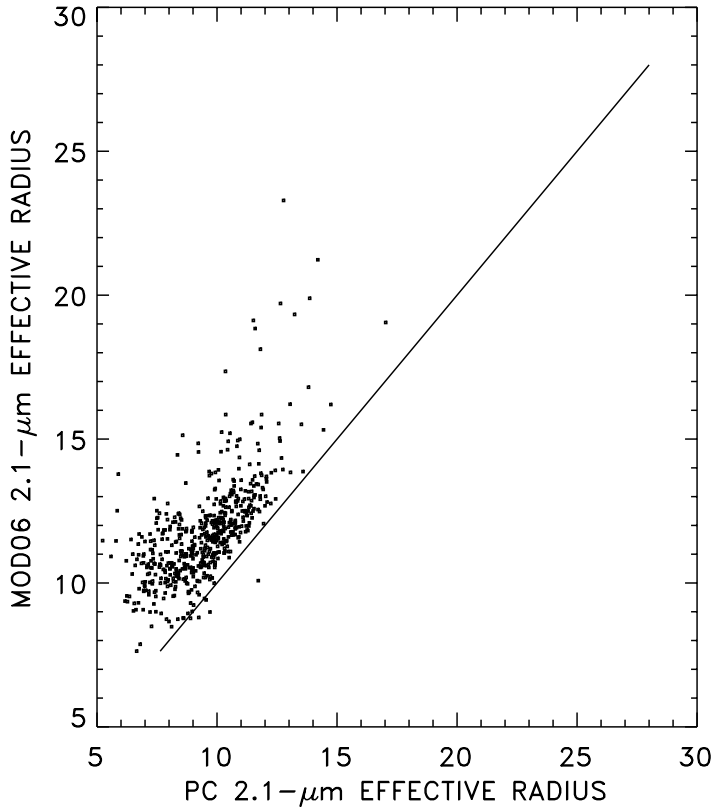
1-km overcast pixels drawn from 50-km scale region containing mostly overcast pixels.

Optical Depth and Droplet Effective Radius for Partly Cloudy Pixels

0.64-μm Optical Depth



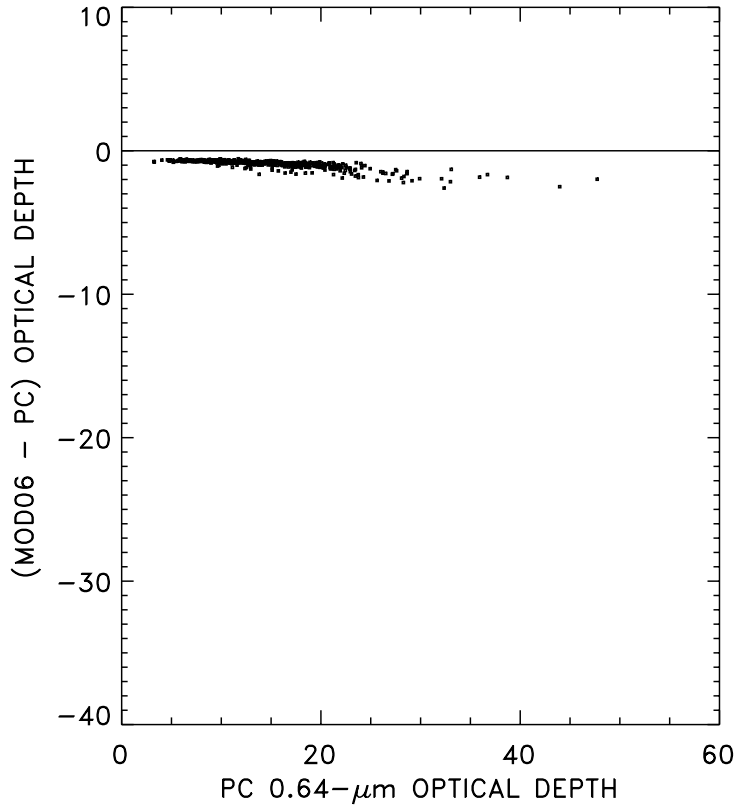
Droplet Radius at 2.1 μm



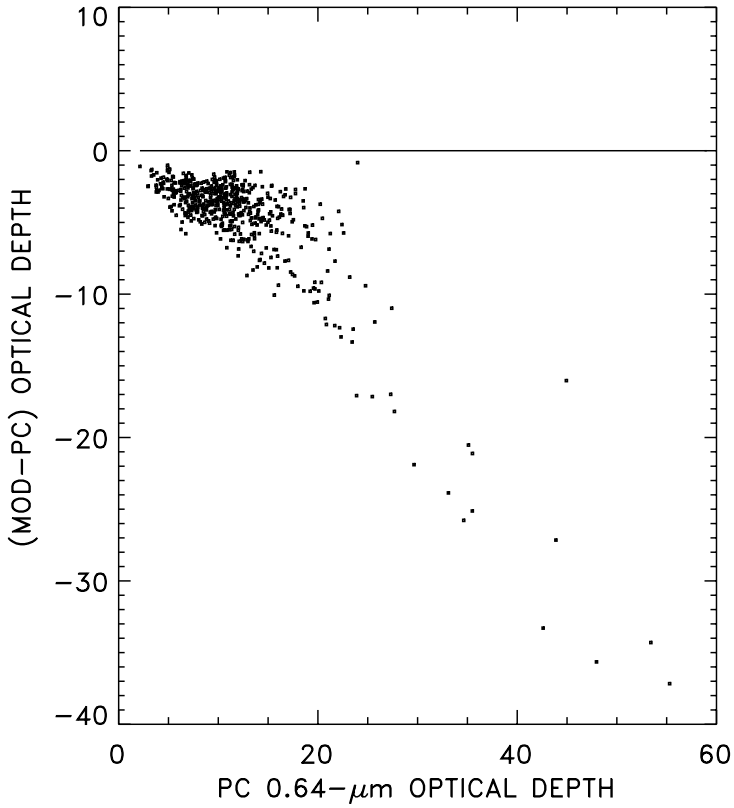
1-km partly cloudy pixels drawn from 50-km scale region containing mostly partly cloudy pixels.

Differences in Optical Depth

Overcast



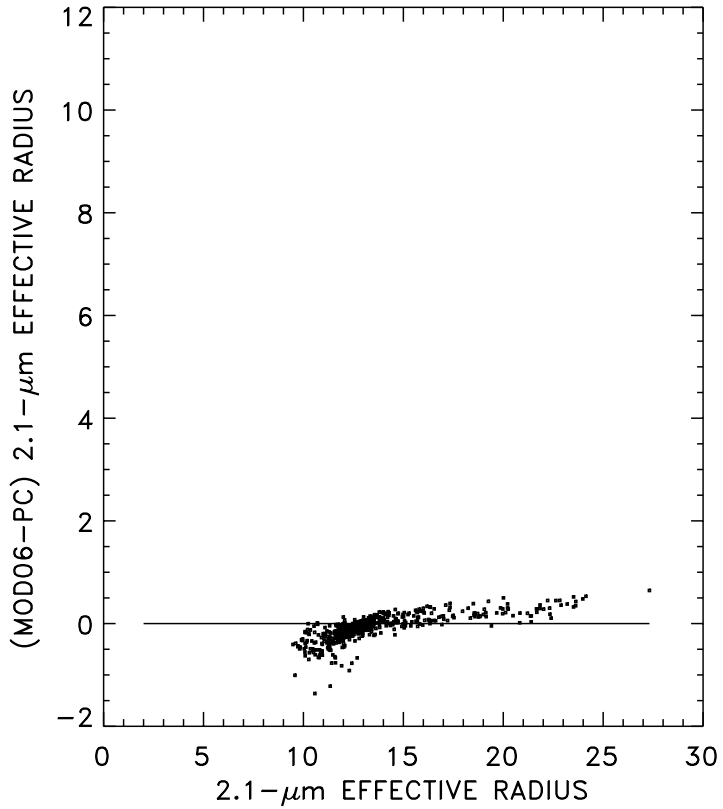
Partly Cloudy



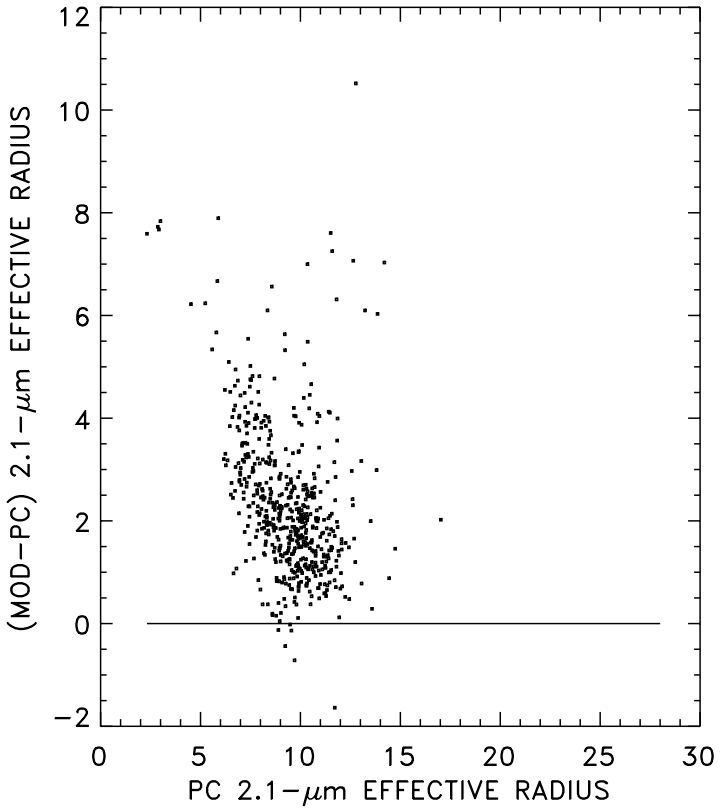
Optical depths in partly cloudy pixels severely underestimated.

Differences in Droplet Effective Radius

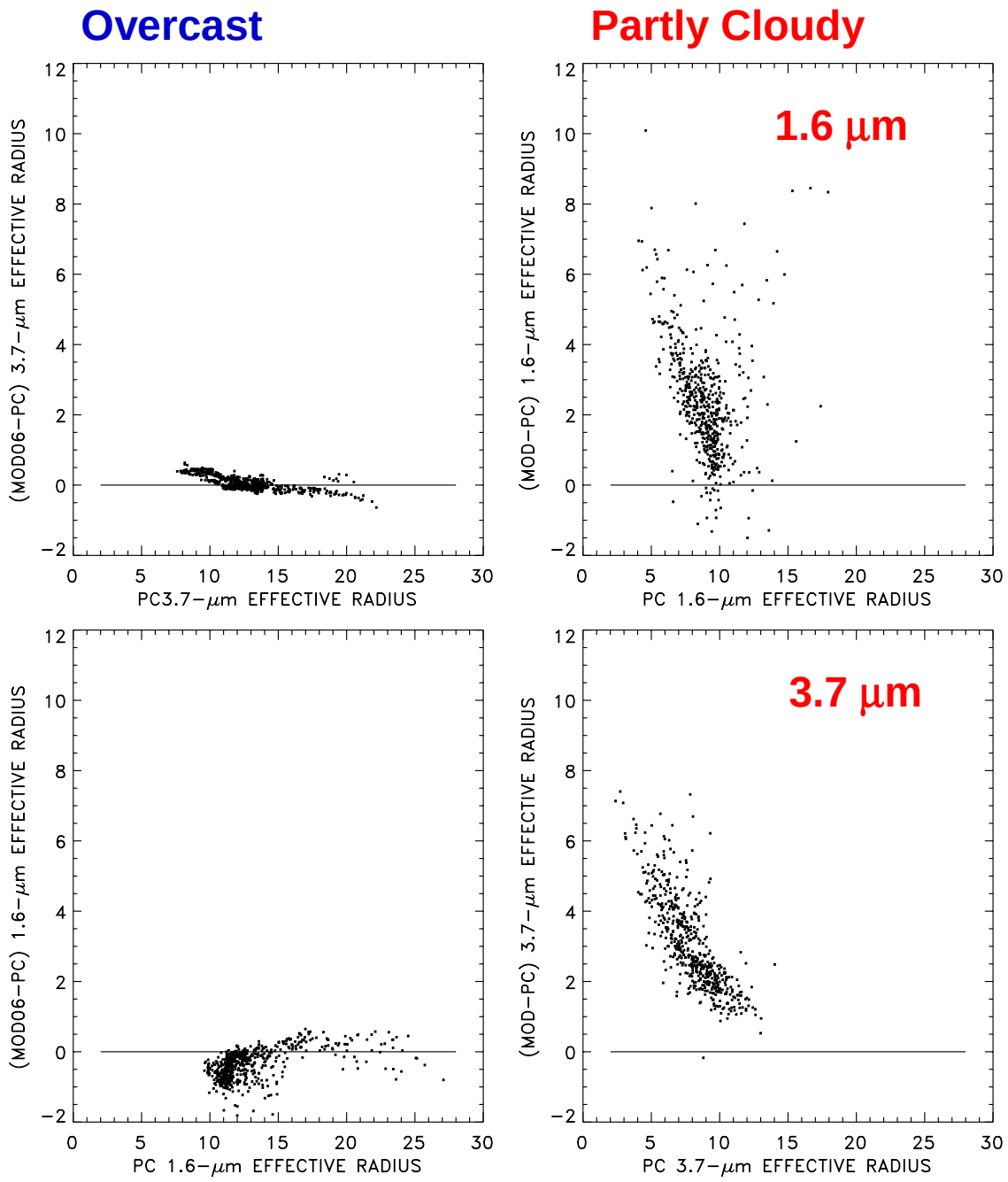
Overcast



Partly Cloudy



Droplet radii in partly cloudy pixels severely overestimated.

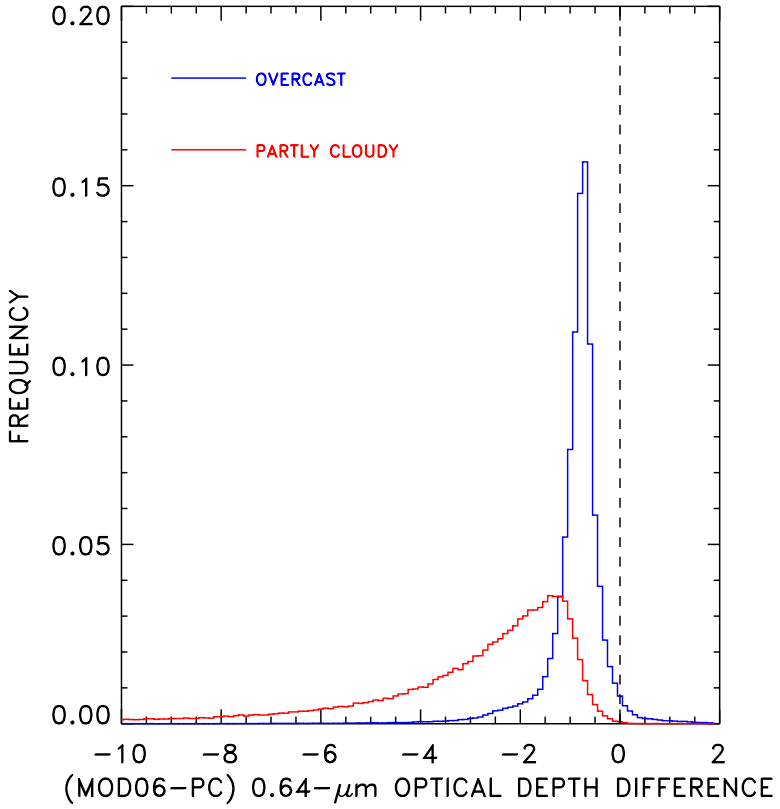


Differences in Droplet Effective Radius

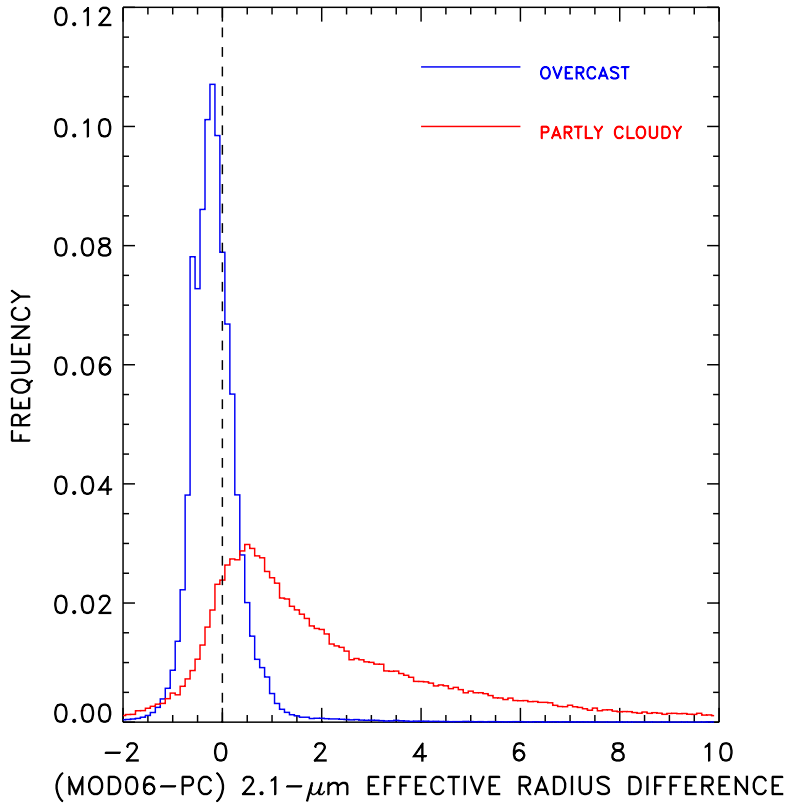
- Retreivals for overcast pixels in good agreement.
- For partly cloudy pixels, MOD06 underestimates visible optical depth and overestimates droplet radius.
- Discrepancies in droplet radius about the same for 1.6, 2.1, and 3.7-μm retrievals.

Distributions of Optical Depth and Droplet Radius Differences

0.64-μm Optical Depth



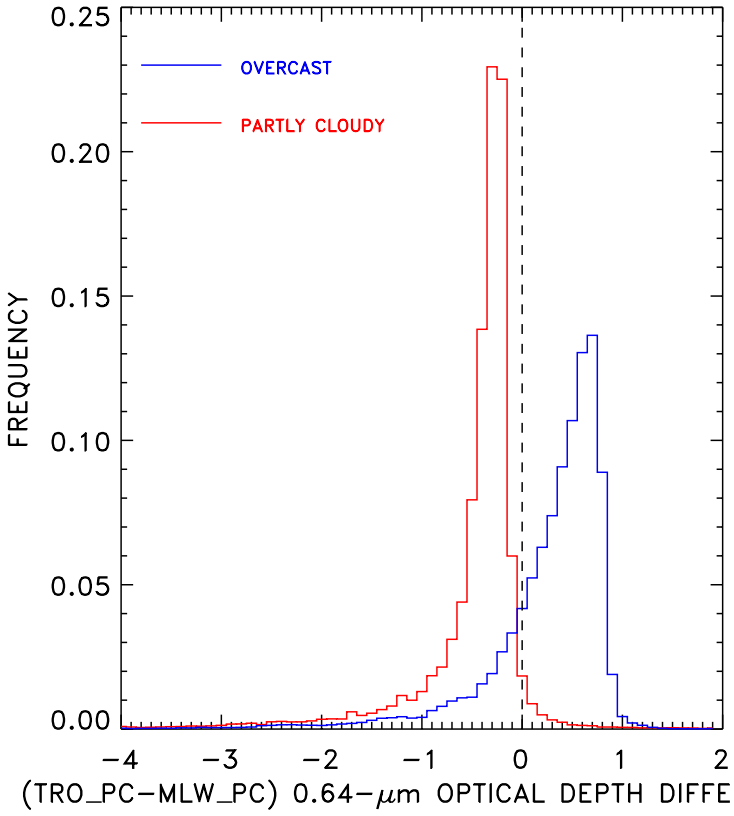
Droplet Radius at 2.1 μm



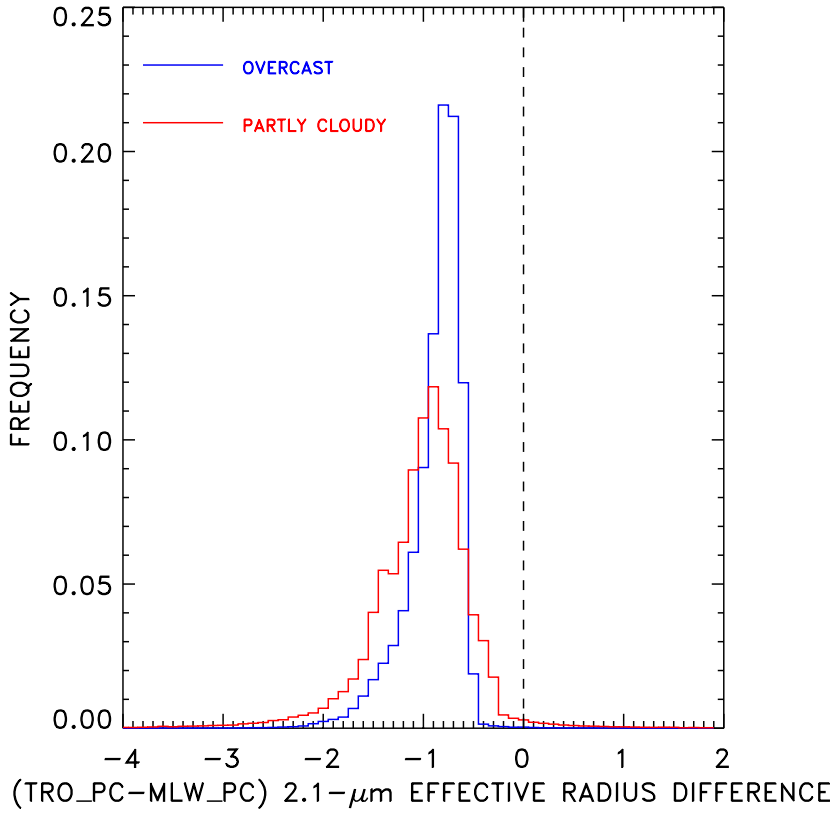
Comparisons drawn from several hundred 50-km scale regions containing single-layered, low-level cloud systems with varying fractions of cloud cover.

Distributions of Optical Depth and Droplet Radius Differences Due to Changes in Atmospheric Profiles

0.64-μm Optical Depth



Droplet Radius at 2.1 μm

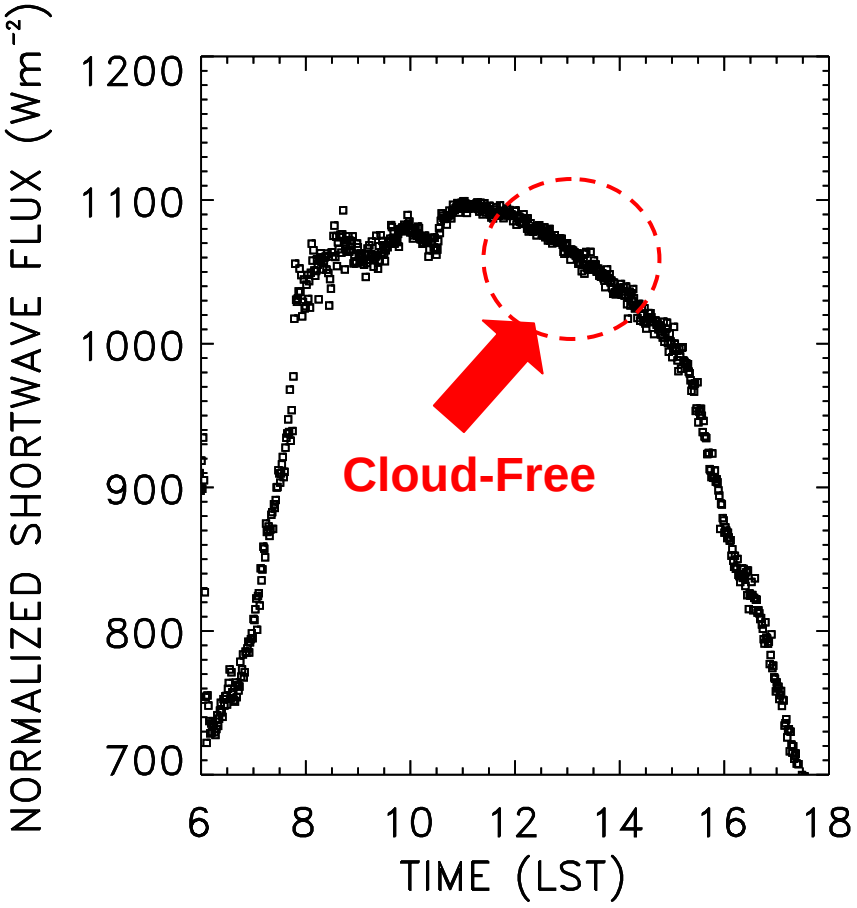


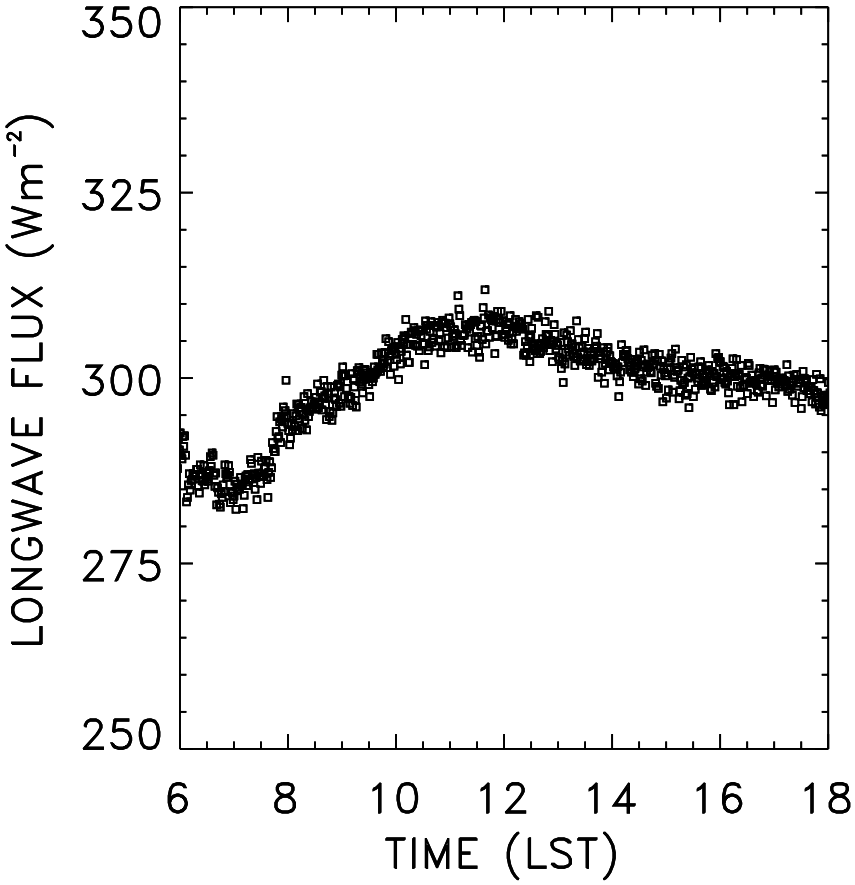
Tropical – Midlatitude winter profiles of temperature, humidity, and ozone.

Shipboard Measurements of Surface Radiative Fluxes

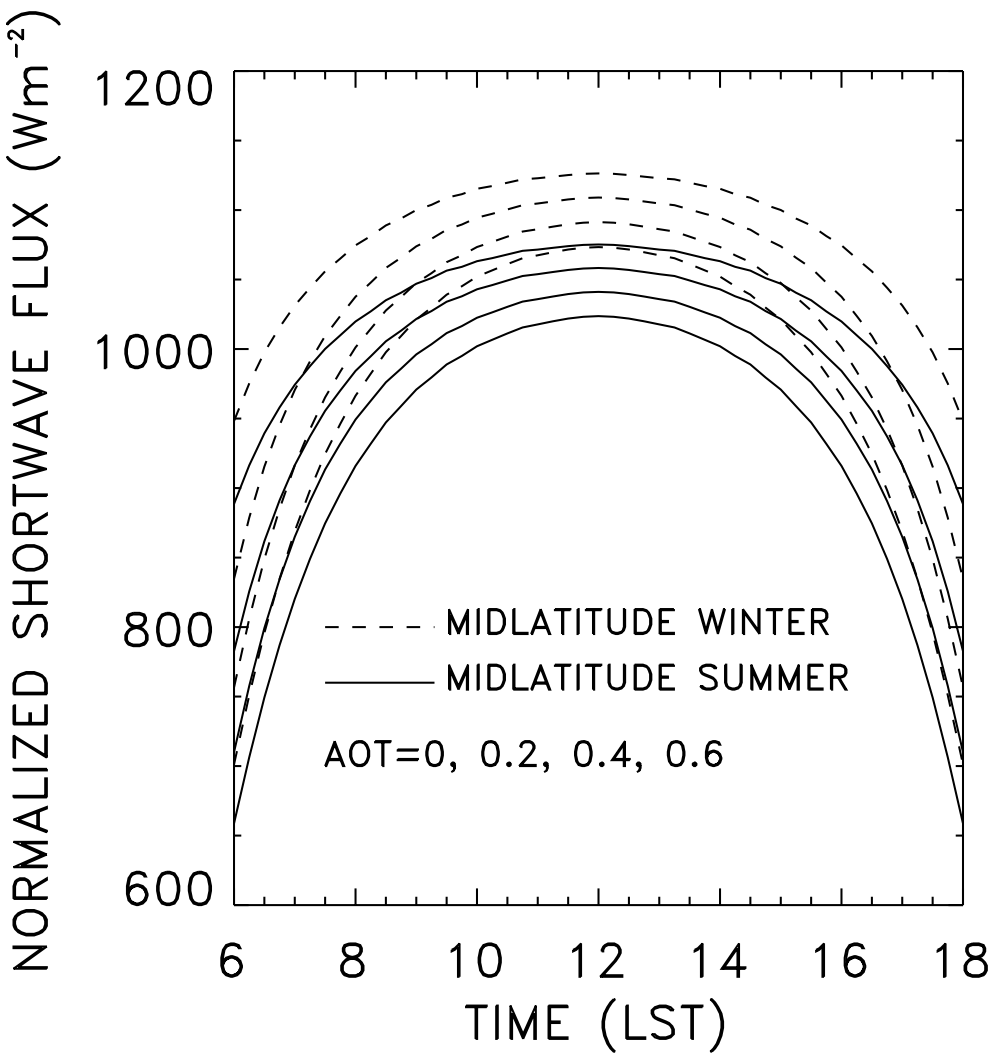
Identification of Cloud-free Scenes

20 May 2001, 44°N 124°W





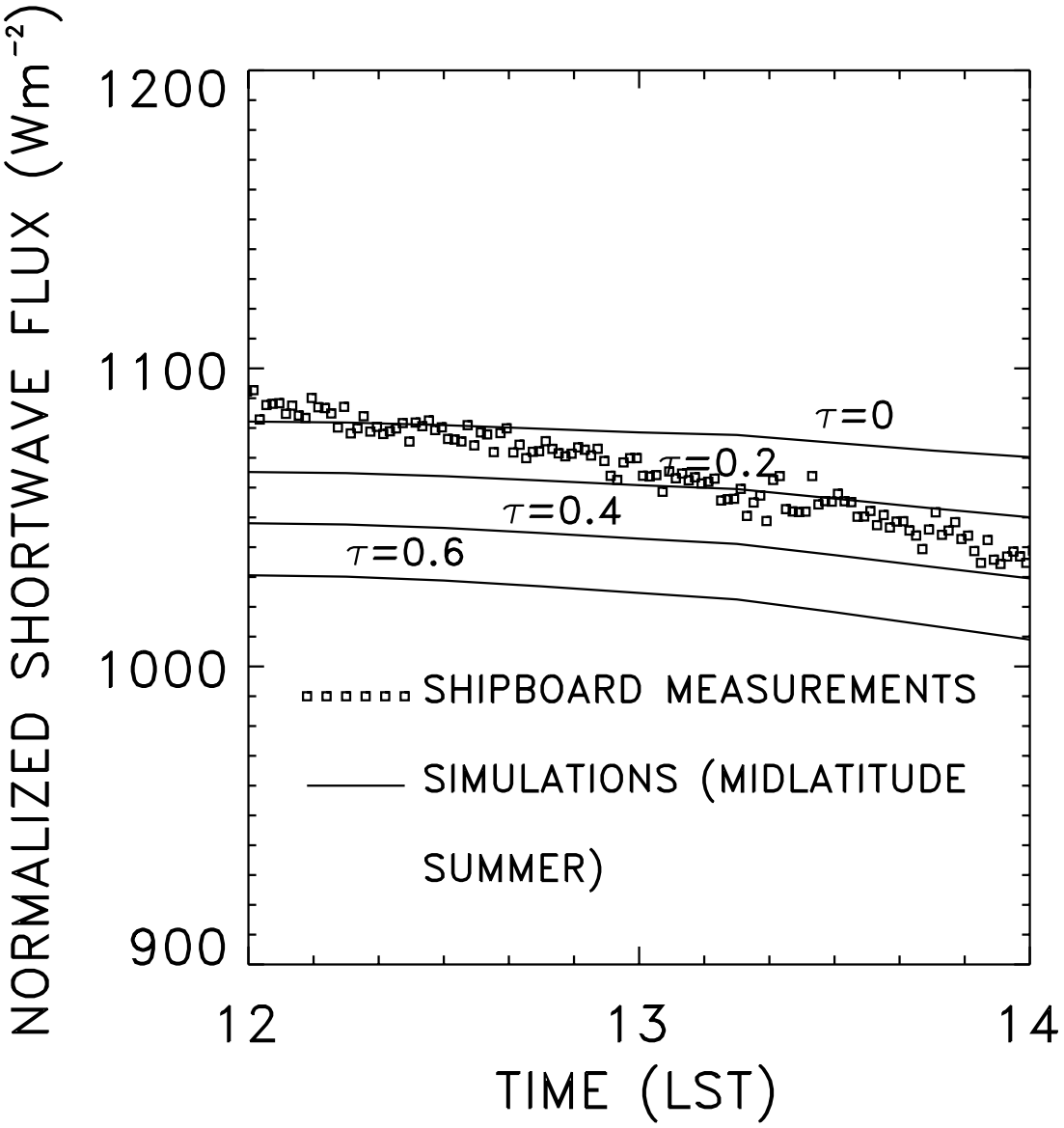
Normalized shortwave = shortwave divided by cosine solar zenith angle.



Surface Shortwave Flux and Atmospheric Composition

Shortwave flux sensitive to water vapor and aerosol burdens.

Calculated and Observed Shortwave Fluxes



- **Midlatitude summertime climatology with 50% moisture used.**
- **Aerosol optical depth adjusted for best-fit.**
- **Range of variation ~ 6% and model estimate appears to be within 2%.**
- **Difference in slopes of observations suggests need to improve radiative transfer calculations.**